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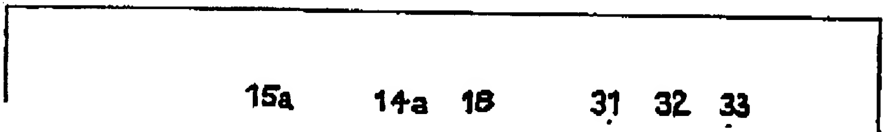
(7

(54) **Smoke pots**

(57) A smoke pot for discharge from a projectile during flight of the latter comprises a housing of annular cross-section formed from an outer tube 10 and an inner tube 13 and closed at the respective ends by annular covers 15a and 15b. The housing is completely filled by a self supporting smoke charge 17 having a plurality of symmetrically disposed blind recesses therein occupied by ignition bodies comprising ignition cartridges 20a embedded in transmission charges 30a and pressed into the recesses under substantially the same pressure as that used to produce the smoke charge. Recesses communicate the ignition cartridges 20a with openings 18 in the inner tube 13 and contain capillary delay tubes 31 for delaying ignition of the ignition cartridges until the smoke pots have reached the ground. The smoke charge 17 contains hexachloroethane, ZnO and metal powder and the transmission charge is of similar composition but with a higher metal powder content.



ERRATUM

SPECIFICATION NO 2032588A

New claims or amendments to claims filed on 6th February 1980. Superseded claims 6
New or amended claims:-

6. A smoke pot as claimed in any one of the preceding claims wherein the zinc oxide has been calcined at at least 900°C before being mixed with the components of the smoke charge.

THE PATENT OFFICE
2 April 1981

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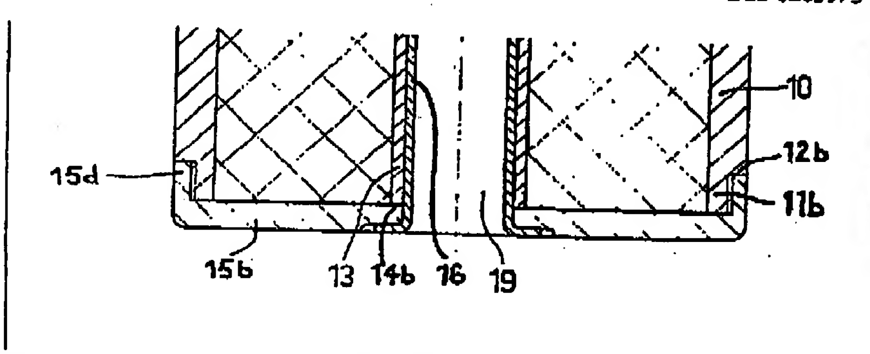

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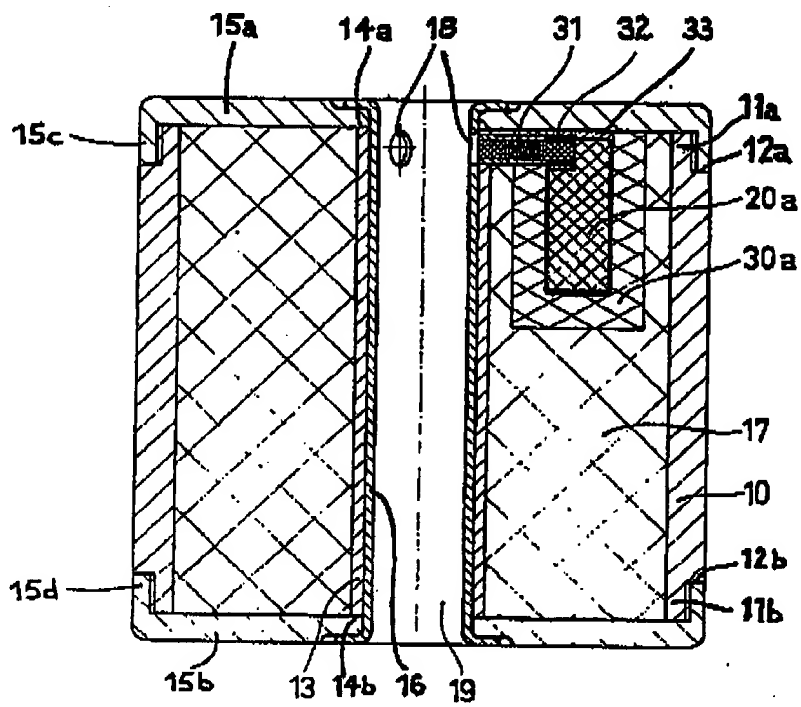
(54) Smoke pots

(57) A smoke pot for discharge from a projectile during flight of the latter comprises a housing of annular cross-section formed from an outer tube 10 and an inner tube 13 and closed at the respective ends by annular covers 15*a* and 15*b*. The housing is completely filled by a self supporting smoke charge 17 having a plurality of symmetrically disposed blind recesses therein occupied by ignition bodies comprising ignition cartridges 20*a* embedded in transmission charges 30*a* and pressed into the recesses under substantially the same pressure as that used to produce the smoke charge. Recesses communicate the ignition cartridges 20*a* with openings 18 in the inner tube 13 and contain capillary delay tubes 31 for delaying ignition of the ignition cartridges until the smoke pots have reached the ground. The smoke charge 17 contains hexachloroethane, ZnO and metal powder and the transmission charge is of similar composition but with a higher metal powder content.



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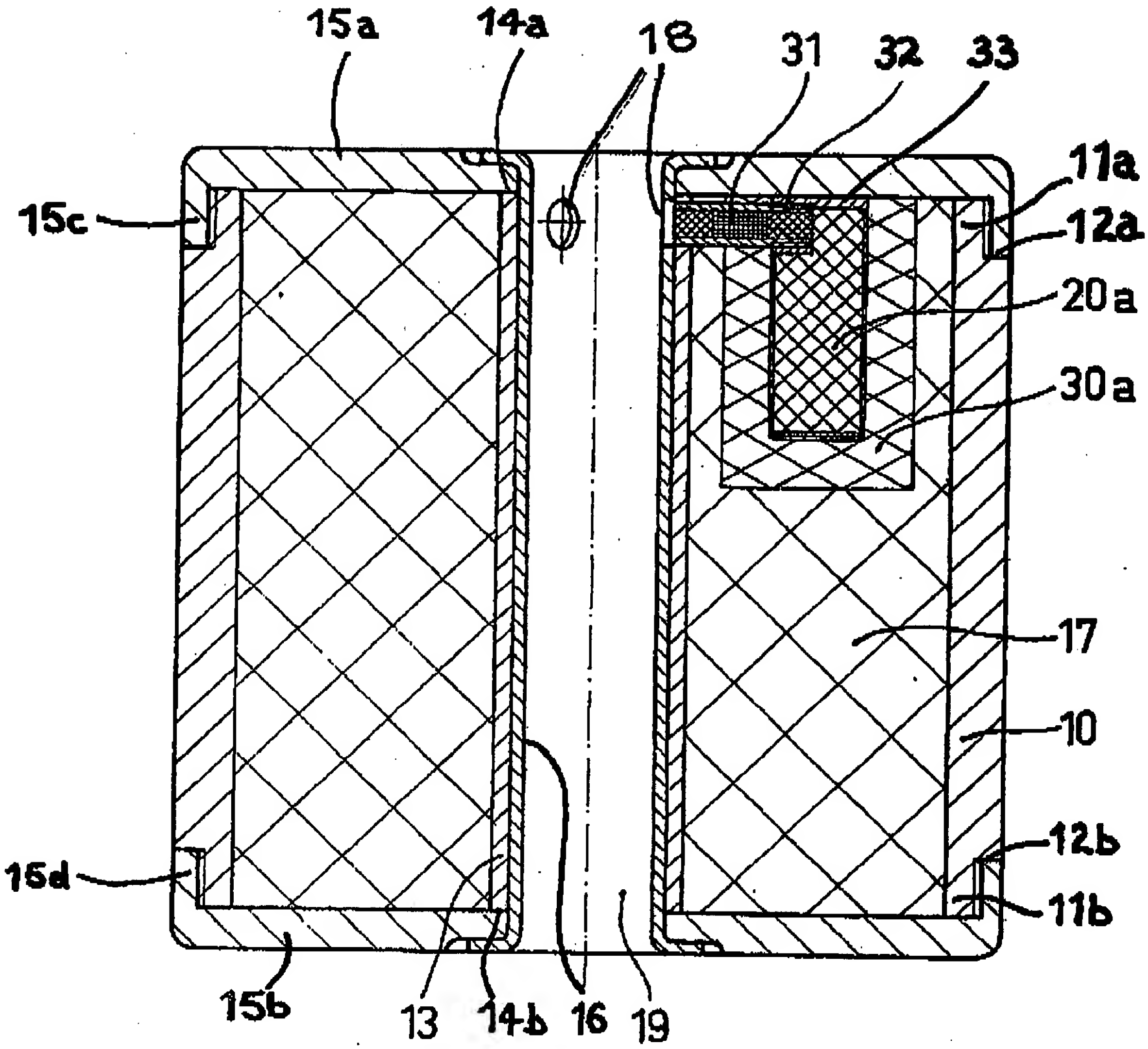
15a
14a
18
31
32
33
11a
12a
15c
20a
30a
17
10
12b
15d
11b
15b
13
14b
16
19

SPECIFICATION

Improvements in or relating to smoke pots

This invention relates to a smoke pot for discharge from a projectile during flight of the latter.

In British patent specification No. 1,546,980 there is described and claimed a smoke pot for use for the aforesaid purpose which comprises a closed metal housing and a self-supporting compressed smoke charge based on hexachloroethane, zinc oxide and metal powder which is disposed in and which completely fills the housing, the ends of the housing being adapted for complete surface contact with any similar smoke pots with which the first mentioned smoke pot may be stacked in a projectile for discharge therefrom. The metal housing will generally consist of two coaxial tubes which form therebetween an annular chamber for the smoke charge and an annular cover at each end. The smoke charge is preferably compressed under a pressure of at least 1,300kp/cm^2 to render it self-supporting. An ignition charge will generally be compressed with the smoke charge to form a common body of uniform compression, the ignition charge preferably consisting of three ignition cartridges which are embedded in the smoke charge symmetrically about the central axis of the smoke pot. The distance between each ignition cartridge and the inner tube is preferably from 5 to 10 mm.

Whilst a smoke pot of such type having an included ignition charge undergoes combustion satisfactorily, problems are encountered in the manufacture thereof. It is intricate and there is a danger that the high pressures will cause ignition of the ignition charge and hence spontaneous reaction of the smoke charge.

According to the present invention, there is provided a smoke pot for use as a shell filling comprising a closed metal housing and a self-supporting compressed smoke charge based on hexachloroethane, zinc oxide and metal powder which is disposed in and completely fills the housing, the housing consisting of two coaxial tubes defining between them an annular chamber for the smoke charge and an annular cover at each end adapted for complete surface contact with any similar smoke pots with which the first mentioned smoke pot may be stacked, which smoke charge is formed with a plurality of symmetrically arranged recesses each housing an ignition body comprising a priming cartridge embedded in a transmission charge, the ignition bodies being pressed into said recesses under a pressure substantially the same as that used to compress the smoke charge, the ignition charges each communicating with the interior of the inner tube of the housing via a capillary delay tube.

This invention stems from the observation that a smoke pot may be produced particularly simply if instead of effecting compression together of ignition charge and smoke charge, the smoke cylindrical passages, and grooves for connecting the blind passages with the internal space of the inner tube of the housing when the pot is closed are formed in the smoke charge and suitably shaped ignition cartridges are inserted into the blind passages. Smoke pots produced in this way perform perfectly adequately when carrying out burn-off tests at the stand but did not perform so well in free flight. In the latter case, the smoke-producing smoke reaction starts spontaneously immediately after discharge from a carrier projectile. When the smoke pots strike the ground smoke production usually ceases for a few minutes. In some cases, however, smoke production fails to recommence.

Although not wishing to be limited thereto, it is believed that the following reasons may be put forward for this behaviour. On discharge and ignition of the smoke pots, the hot combustion gases from the projectile which are to provide an ignition jet for the smoke pot passes into the centre of the pot and enters the ignition cartridges under a pressure of about 300 bar through fire gaps which unavoidably exist between the smoke charge and the ignition cartridges. The ignition jets possess mechanical and thermal energy sufficient to tear open the casings of the ignition cartridges and to ignite the ignition charges over a large area. The resulting rapid burn-off of the ignition charge causes an extremely spontaneous and intensive initiation of the smoke-producing reaction.

As it undergoes combustion, the smoke charge is for a short while in the liquid phase. Part of it is therefore ejected from the housing of the smoke pot as a result of the suction effect present during flight at the opening of the inner tube and as a result of the outwardly acting pressure of smoke being generated. This latter phenomenon is also responsible for loss of part of the smoke charge undergoing combustion. In this way, the mass of smoke charge undergoing combustion has been considerably reduced by the time the smoke pot hits the ground. Moreover, the free space in the housing has increased. The close contact between ignited smoke charge and smoke charge yet to be ignited no longer exists, i.e. the conditions for transmission of heat are not longer optimal. Moreover, on impact with the ground, the contents of the housing of the smoke pot are jolted and mixed together and the layer of smoke charge undergoing reaction breaks off from unreacted smoke charge therebelow. The net effect of all these factors is that conditions are unfavourable for combustion to continue after impact of a smoke pot with the ground and indeed combustion usually only recommences after an extended period, if at all.

It is with the object of avoiding this behaviour that such a simple form of smoke pot having a self-supporting smoke charge with pre-formed recesses and inserted ignition cartridges was modified. For this purpose, there was used an ignition body consisting of an ignition cartridge and a jacket of a smoke charge pressed

each

of the recesses formed in the main smoke charge. Such a combined ignition body was produced in the knowledge that it is simpler and safer to compress an ignition cartridge with a relatively small amount of smoke charge than with the entire smoke charge. By operating in this way it is possible to ensure that large area ignition of the ignition charge and the consequent spontaneous burn-off do not occur. However, the burn-off behaviour is still not satisfactory because of the gap in the smoke charge itself. Whilst only a weak cessation of the smoke producing reaction took place on the stand with such a type of smoke pot, when such a smoke pot was employed in a projectile, the interruption in the smoke producing reaction was more pronounced because of the jolt on impact with the ground which as before resulted in cessation of the smoke producing reaction.

It was subsequently found that the particular advantage of introducing on a combined ignition body into a recess in a preformed smoke charge combined with satisfactory combustion behaviour could be achieved if a delay was arranged in advance of the ignition cartridges so as to delay ignition of the ignition charges until after the smoke pot hit the ground. The contents of the smoke pot constitutes a rigid structure even at that stage because of the absence of any spaces therein and hence the jolt on impact with the ground does not alter the disposition of the contents of the smoke pot in any way and hence effect the functioning thereof. Hence, by constructing a smoke pot in accordance with the invention, it was possible to achieve combustion behaviour after flight which was the same as that during tests on the stand.

Improved reliability is achieved with a smoke pot embodying this invention if provision is made to prevent the possibility of the delay member being by-passed by the ignition jet. For this purpose, it is preferred that the delay member be screwed into the casing of the ignition cartridge right up to the base of its threads and that the threads be additionally sealed by means of an adhesive composition that is compatible with hexachloroethane.

The ignition cartridge of a smoke pot embodying this invention is encased in a smoke charge because, as previously indicated herein, it is generally simpler and safer to compress an ignition cartridge with a relatively small amount of smoke charge than with the whole smoke charge. Nevertheless, as previously mentioned, because of the separate production of two parts of the smoke charge which thus results so that there is a small gap between the two, there will generally be a small interruption in the production of gas by the respective parts of the overall smoke charge. This interruption in smoke production can be avoided if the smoke charge pressed around the ignition cartridge undergoes reaction more rapidly and therefore produces a hotter smoke than the main smoke charge. This effect can be achieved quite readily when employing smoke ch... the same components if the content of metal powder in the smoke charge in which the ignition cartridge is pressed is higher than the metal powder of the main smoke charge. As a result of the more rapid reaction of this latter charge serving as a transmission charge, a more spontaneous and intensive start to the overall smoke producing reaction is achieved.

For a better understanding of the invention and to show how the same can be carried into effect, reference will now be made, by way of example only to the accompanying drawing which is a longitudinal section through a smoke pot of the invention.

In its general characteristics, the smoke pot is similar to that shown in the drawing accompanying Specification No. 1,546,980. Referring to the drawing accompanying this application, the smoke pot thus comprises an outer tube 10 which has an annular shoulde 12*a*, 12*b* at its respective ends. The references 11*a*, 11*b* denote the annular rims formed by the shoulders 12*a*, 12*b*. Disposed coaxially inside the outer tube is an inner tube 13 of which the edges 14*a*, 14*b* align with the shoulders 12*a*, 12*b*. The references 15*a* and 15*b* denote two annular covers which are formed on the inner edges of outer flanges 15*c* and 15*d* with screw threads which correspond with screw threads formed on the outer surfaces of the annular rims 11*a*, 11*b*. A retaining tube 16 fits into the inner tube 13, being flanged into recesses in the annular covers 15*a*, 15*b*. The annular chamber between the outer tube and the inner tube 13 is filled with a smoke charge 17 which communicates through openings 18 (only two shown) in the inner tube 13 and the retaining tube 16 with the interior 19 of these tubes, the so-called degassing channel.

A single ignition cartridge 20*a* is visible in the drawing; there are three altogether disposed symmetrically around the longitudinal axis of the smoke pot. The ignition cartridge 20*a* is surrounded by a transmission charge 30*a*. Disposed between the ignition charge 20*a* and an opening 18 aligned therewith is a capillary delay tube 31.

In the process of assembling the smoke pot, the housing 10 is first filled with the smoke charge 17 and this is compressed under a pressure of about 1,300 kp/cm² to the level of the annular shoulder 12*a*. Subsequent to the compression of the smoke charge, vertical blind passages are formed in the compressed smoke charge 17 at a distance which preferably amounts to from 5 to 10 mm from the inner tube 13. In addition, horizontal grooves are formed in the compressed smoke charge 17 in alignment with the openings 18. Insert bodies each consisting of an ignition cartridge 20*a* set in a transmission charge 30*a* are then pressed into the blind passages employing approximately the same pressing conditions as previously employed for producing the smoke charge 17. A capillary delay tube 31 is then placed in each groove and the smoke pot is enclosed by means of the lid 15*a*.

smoke charge having the same composition as the smoke charge 17, but for a higher content of metal powder, usually aluminium powder so as to improve the ignition characteristics of the smoke pot. The capillary delay tube 31 may have an external thread so that it can be screwed into an internal thread in an aperture 32 in the casing 33 of the ignition cartridge 20*a*. The delay tube 31 may if desired be screwed up against a sealed stop. The screw threads can likewise be sealed by means of an adhesive composition. A firm seal serves to ensure that a concentrated ignition jet is only able to ignite the capillary tube 31 and not to penetrate directly into the interior of the casing 33.

In all respects other than those connected with the manner of inclusion of the ignition cartridge, a smoke cup embodying this inventiom may be of like type to that described in Specification No. 1,546,980. Thus, as shown in the accompanying drawing, the outer tube is shouldered at each end to receive the respective annular cover which is secured to the tube by cooperating threads on the rim of the cover and the sidewall of the housing in its shouldered portion. The annular cover lies flush with the end of the outer tube. In order to possess self-supporting properties, the smoke charge which completely fills the annular chamber but for the ignition cartridge and delay tube is preferably compressed under a pressure of at least 1,300 kp/cm^2.

It is because the smoke charge forms a substantially self-supporting element of the smoke pot that it is possible for the wall thicknesses of the housing to be kept comparatively thin. For the same volume of smoke pot; it is possible to introduce more smoke charge than in the case of a smoke pot where the metal housing is the sole supporting element. For reasons of specific strength, weight and cost, high strength aluminium is the most suitable material for the housing.

The composition of the ignition charge of the ignition cartridges must be such that, on the one hand, the thermal energy is sufficient to ignite the smoke charge 17 but, on the other hand, is not so intense as to cause explosive initiation of the smoke-forming reaction, in which case the housing would not withstand the sudden increase in gas pressure. Accordingly, the reaction temperature of the ignition charge must lie in a certain temperature range. In addition, the ignition charge must flux very quickly on burning up to ensure that it is not forced outwards under the effect of centrifugal force (rotational speed typically 16,000 rpm), as a result of which it could again result in overviolent initiation of the smoke charge 17. According to the invention, this problem is solved by using a reaction mixture of Si/Pb_3O_4 in a ratio of about 30:70.

Highly compressed smoke charges based on hexachloroethane, zinc oxide and metal powder, of the type that have to be used here, may give rise to difficulties which were previously unknown in because, when these smoke charges are highly compressed, they sometimes show poor stability in storage which, in extreme cases, can result in complete failure of the ammunition. This instability is attributable to the water content of the smoke charge, this water content being much more harmful to highly compressed smoke charges than to the conventional smoke charges of comparatively low compression. Exhaustive tests have shown that the stability of a smoke charge in storage is primarily determined by its zinc chloride content. Part of this chloride is actually introduced into the smoke mixture as an impurity of this smoke charge. Zinc chloride is highly hygroscopic and, hence, is responsible for the fact that, even when produced from predried chemicals, smoke charges very quickly absorb moisture from the air and, accordingly, cannot be effectively processed under high pressures.

To avoid this difficulty, the zinc oxide may be calcined at at least 900°C before it is mixed with the other components of the smoke charge. This calcining treatment has a two-fold effect. Firstly, any zinc chloride present in the zinc oxide is volatilised. Secondly, the formation of chloride during compression of dry charge is avoided. Accordingly, the compressed smoke charge shows no further tendency to absorb water. Thus, it was not possible to detect any chloride, for example in a smoke charge produced with calcined zinc oxide, even after storage for 5 months. By contrast, a smoke charge of the same composition, produced from non-calcined zinc oxide, was found to contain 1.3% of zinc chloride after only 2 days. In consistency with these findings, there had been no change in the reaction time of the first calcined charge over the 5-month storage period, whereas in the case of the second non-calcined smoke charge, the reaction could no longer be initiated after only a few weeks. Accordingly, it is possible in the process according to the invention to start with the known basic components in their standard commercial-grade form. In general, there is no need to pretreat the hexachloroethane and the metal powder because standard commercial-grade hexachloroethane and metal powder are substantially anhydrous and free from hygroscopic impurities, above all zinc chloride and zinc sulphate but these impurities are now removed by heating the zinc oxide to a temperature above 900°C (calcination). After this calcining treatment, the three components of the smoke charge may be mixed together in the usual way. The mixture is then compressed under a pressure of at least 1,300 kp/cm^2. Collection of the zinc oxide prior to mixture with other constituents enables use to be made of zinc oxide which, as a result of incorrect or poor storage, no longer appears suitable for normal mixtures. Similarly, even extremely moist zinc oxide can be made re-usable by calcination before use.

Instead of using standard commercial-grade zinc oxide, it is also possible to use zinc oxide which *ab initio* is free from hygroscopic impurities

case, there is no need for the calcining treatment.

Smoke charges based on hexachloroethane and zinc oxide additionally contain a proportion of metal powder as reaction accelerator. Of the powders normally used for this purpose, aluminium powder is particularly suitable in the present case because the housing material usually also consists of aluminium. This standardisation precludes the formation of local elements and, hence, reciprocal corrosive destruction.

The formation of chloride is also a measure of the passivation of a smoke charge. By virtue of the fact that it does not occur in cases where calcined charges are used, the proportion of metal powder can be reduced by half in comparison with charges that are not completely dry. Since the aluminium not only contributes towards smoke formation, but also increases the residue, the smoke yield is also considerably increased by the present invention.

As in the case of the smoke pots of Specification No. 1,546,980 a smoke charge which was stable on storage and which produced a satisfactorily long smoke emission time with the smoke pot of the invention was one having the following composition:

47.25% of ZnO (calcined)
47.25% of hexachloroethane
5.50% of aluminium powder.

CLAIMS

1. A smoke pot for use as a shell filling comprising a closed metal housing and a self-supporting compressed smoke charge based on hexachloroethane, zinc oxide and metal powder which is disposed in and completely fills the housing, the housing consisting of two coaxial tubes defining between them an annular chamber for the smoke charge and an annular cover at each end adapted for complete surface contact with any similar smoke pots with which the first mentioned smoke pot may be stacked, which smoke charge is formed with a plurality of symmetrically arranged recesses each housing an ignition body comprising a priming cartridge embedded in a transmission charge, the ignition bodies being pressed into said recesses under a pressure substantially the same as that used to compress the smoke charge, the ignition charges each communicating with the interior of the inner tube of the housing via a capillary delay tube.

2. A smoke pot as claimed in claim 1, wherein the smoke charge is compressed under a pressure of at least 1,300 kp/cm^2.

3. A smoke pot as claimed in claim 1 or 2, which contains three ignition cartridges which are embedded in the smoke charge symmetrically about the central axis of the smoke pot, the distance between each ignition cartridge and the inner tube amounting to from 5 to 10 mm.

4. A smoke pot as claimed in any one of the preceding claims, wherein the transmission charge has the same composition as the smoke charge but for an amount of metal powder which is greater with respect to the hexachloroethane and zinc oxide than in the smoke charge.

5. A smoke pot as claimed in any one of the preceding claims, wherein the ignition charge of the ignition cartridges consists of a mixture of silicon and lead oxide (Pb_3O_4) in a ratio by weight of 30:70.

6. A smoke pot as claimed in any one of the preceding claims wherein the zinc oxide has been calcined at at least 900°C before being mixed with the other components of the smoke charge.

7. A smoke pot as claimed in claim 6, wherein the smoke charge consists of 47.25% by weight of calcined zinc oxide, 47.25% of hexachloroethane and 5.50% of aluminium powder.

8. A smoke pot as claimed in any one of the preceding claims, wherein the capillary delay tube enters into screw threaded engagement with an opening in the inner tube, being screwed thereinto up to the thread stop with the screw threads being sealed up by means of a sealing composition.

9. A smoke pot, substantially as hereinbefore described with reference to the accompanying drawing.

10. A process for the production of a smoke pot as claimed in any one of the preceding claims, which comprises introducing the smoke charge into the smoke pot housing, compressing the smoke charge under a pressure of at least 1,300 kp/cm^2 so that the compressed smoke charge completely fills the smoke pot housing, forming in the compressed smoke charge a plurality of blind recesses symmetrically disposed around the longitudinal axis of the smoke pot housing and grooves extending from the blind recesses to openings in the inner tube of the housing and placing a said ignition body in each said recesses and a capillary delay tube in each said groove, and then closing the smoke pot by means of a said annular lid.

11. A process as claimed in claim 10, wherein the ignition bodies are pressed into said recesses under a pressure of at least 1,300 kp/cm^2.

12. A process for the production of a smoke pot, substantially as described herein with reference to the accompanying drawing.

13. A smoke pot which has been produced by the process claimed in any one of claims 10 to 12.

New claims or amendments to claims filed on 6th February 1980.

Superseded claims 1, 3, 8, 10, 12 and 13.

New or amended claims:—

1. A smoke pot for use as a shell filling comprising a closed metal housing and a self-supporting compressed smoke charge based on hexachloroethane, zinc oxide and metal powder which is disposed in and completely fills the housing, the housing consisting of two coaxial tubes defining between them an annular chamber for the smoke charge and an annular cover at each end adapted for complete surface contact with

mentioned smoke pot may be stacked, which smoke charge is formed with a plurality of symmetrically arranged recesses each housing an ignition body comprising an ignition cartridge embedded in a transmission charge, the ignition bodies being compressed under a pressure substantially the same as that used to compress the smoke charge, the ignition charges each communicating with the interior of the inner tube of the housing via a capillary delay tube.

3. A smoke pot as claimed in Claim 1 or 2, which contains three ignition bodies which are embedded in the smoke charge symmetrically about the central axis of the smoke pot, the distance between each ignition cartridge and the inner tube amounting to from 5 to 10 mm.

8. A smoke pot as claimed in any one of the preceding claims, wherein each capillary delay tube enters into screw threaded engagement with an opening in a casing for its associated priming cartridge, being screwed thereinto up to the thread stop with the screw threads being sealed up by means of a sealing composition.

10. A process for the production of a smoke pot as claimed in any one of the preceding claims, which comprises introducing the smoke charge into the smoke pot housing, compressing the smoke charge under a pressure of at least 1,300 kp/cm^2 so that the compressed smoke charge completely fills the smoke pot housing, forming in the compressed smoke charge a plurality of blind recesses symmetrically disposed around the longitudinal axis of the smoke pot housing and grooves extending from the blind recesses to openings in the inner tube of the housing and placing a said ignition body in each said recess and a capillary delay tube in each said groove, and then closing the smoke pot by means of a said annular lid.

12. A process as claimed in Claim 10, wherein the ignition bodies are pressed under a pressure of at least 1,300 kp/cm^2 before being placed into said recesses.

13. A process for the production of a smoke pot, substantially as described herein with reference to the accompanying drawing.

14. A smoke pot which has been produced by the process claimed in any one of Claims 10 to 13.

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